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pair of temporary abdominal appendages on each segment (uro-mere); so also has the Lepidopterous and Coleopterous embryo, which points back to a common, Scolopendrella-like type; this also possibly indicating a still earlier, worm-like, Peripatus-like ancestor for Myriopoda and Hexapoda at least, if not Arachnida. For previous discussions as to the origin of insects the reader is referred to the writings of Fritz Müller, Brauer, Lubbock, and the author.

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THE MINK OR HOOSIER FROG.

BY J. H. GARNIER, M.D.

THIS frog, (*Rana septentrionalis*) seems comparatively unknown, and is found in localities far apart. It inhabits spring creeks and rivers, but in lakes and ponds of the purest water I have never seen it, nor captured a single specimen. It is quiet and solitary in its habits, never associating in numbers like the bull-frog (*R. catesbiana*), nor the green frog (*R. fontinalis*). It makes its appearance in April. It was first named by Professor S. F. Baird, now Secretary of the Smithsonian Institution. Mr. Rice published some notes concerning it, which I have been unable to procure, and therefore furnish such particulars as have come under my own personal observation. It is a silent and unobtrusive species, and emphatically a river frog. It is never seen in fields nor woods, but as the observer walks by the banks of a brook, it seldom allows him to approach its lurking place, but, being very wary, dives into the stream, generally making for the center, where it seeks the cover of some friendly stone, buries itself in the mud, or conceals its body among the water plants. If taken in the hand it emits a strong odor of musk and garlic, or more properly the disagreeable scent of the mink; this is sufficiently powerful to adhere to the hand for a time, but soon passes away. It preys on water beetles and similar insects, but seems especially partial to the *Julus* family, having generally found it in the stomachs examined. Why it was termed "hoosier frog" I do not know, and I may be allowed to add the name of "mink frog," which has a positive meaning.

The tadpoles rest in little bays, or may often be seen in the most rapid current. If disturbed, like the adult, they dart into the middle, and it is no easy matter to secure specimens of the nearly per-

fected larva. They are very active and vigilant. I can aver that I have seen the larva dart into the river from the edge, at the distance of a rod or more from where I was standing, and have had no small trouble to secure even a few subjects.

The following measurements are the mean of twelve adults, in inches, and carefully correlated:

From end of snout to end of great toe.....	$6\frac{3}{8}$	inches.
From snout to vent.....	$2\frac{3}{4}$	"
Breadth of head a full.....	$\frac{7}{8}$	"
Thigh in length.....	$1\frac{1}{4}$	"
Leg do.....	$1\frac{1}{4}$	"
Tarsus do.....	$\frac{1}{2}$	"
External toe do.....	1	"
Second, or longest in all frogs, do.....	$1\frac{1}{4}$	"
Third do.....	$\frac{1}{2}$	"
Fourth do.....	$\frac{1}{2}$	"
Fifth do. ¹	$\frac{3}{8}$	"
Arm in length.....	$\frac{5}{8}$	"
Forearm do.....	$\frac{1}{2}$	"
External finger do.....	$\frac{1}{6}$	"
Longest finger, or second, do.....	$\frac{9}{16}$	"
Third, or shortest, do.....	$\frac{1}{4}$	"
Thumb and pad do.....	$\frac{1}{2}$	"
From internal canthus to end of nose.....	$\frac{3}{8}$	"
From angle of mouth to symphysis of jaws.....	$\frac{5}{8}$	"

This frog is easily distinguished from all others in North America by the peculiar minky odor and by the beautiful hazel-brown of the iris, features persistent in all specimens and in all stages when in life. These disappear, of course, in alcohol. The upper and lower lids are edged with a semi-transparent greenish border. The nostrils are small, black, and with a raised margin. The ears are dark brown, marbled with sooty black. Above each eye may generally be found a black blotch or spot, and a rectangular parallelogram of black on each shoulder. There is a slight band of raised skin from the angle of the mouth disappearing at the shoulder, but the lateral fold is absent in all stages.

The coloration of this species is peculiar, and is so persistent and so little varied in the many specimens I have examined as not to permit it to be confounded with any other. The back is a dark olive-green, mixed with sooty brown. There are sooty

¹The foot when spread forms nearly a parallelogram, measuring to its outside edge $1\frac{1}{8}$ inches long and $\frac{5}{8}$ broad, which is large in proportion to the size of the species.

blotches of an irregular round form, especially towards the rump, each encircled with a dirty greenish ring or marbling. The head is of a more uniform greenish-brown. The upper lip green, shading to dirty white under the snout. Lower lip white. The upper surface of the thighs, legs and tarsus are blotched in two rows of spots, but not regularly banded, as also the arms. Soles of feet and palms of hands a uniform sooty brown. The upper surfaces of the external toe and the web attaching it to the second is of a sooty brown; the remaining three toes and webs are dirty white. The throat and all the inferior surfaces are of a beautiful paper white, with creamy or gentle grass-green tinges on the throat, giving a very pleasing effect. Occasionally a subject is found with a few scattered spots on the edges of the abdomen, or on the thighs, but as a rule the line of demarkation between the upper and under surface is very well pronounced. The lower eyelids are transparent, becoming white in alcohol. The stomachs of many have been examined by me, and they contained mostly *Carabus*, *Julus* and water insects, and on two occasions some little fish, chubs, if I remember correctly, about an inch long. Thus their food is like that of other frogs. On examining specimens taken on 20th July, 1883, the formation of the ova was considerably advanced. Like the bull-frog and green frog, it retires early to hibernate, and after the first sharp frost they all go to repose, and for about six or seven months are never seen.

In summer they may often be seen with the head and a bit of the back out of water, resting among plants on the borders of streams, and where the *Potamogeton* is in bunches, or the *Ranunculus* is in beds, the herpetologist may likely secure his specimens.

But if the frog once disappears, he generally keeps from view till all probable danger is past. It is useless to expect it to reappear at the spot it left, as it dives several yards, it may be, rods, before it stops. I have occasionally waited half an hour or more, watching one that has so dived beside a stone, in the current or otherwise. Perhaps they may have been really frightened, and the feeling of fear may have remained, or they may have followed some law of nature implanted within them in keeping concealed for such a protracted period. Occasionally I have heard their notes after they were secured and in my collecting case; but then it seemed truly a note of distress, and was in a different

tone and key from that rarely heard on the open stream. The loud-throated bull-frog and his equally noisy congener, the marsh or green frog, I do not consider indulge in the "chant amour" during the heat of the summer, as nobody ever saw them in coitu, at least I never did, although I have carefully watched and made many inquiries, both from whites and Indians. But how this takes place, or when, I cannot personally state for a fact.

The tadpoles of some *Batrachia* congregate in schools, as may be seen with the *Bufo lentiginosus*, *Rana catesbiana*, *R. fontinalis*, &c., but that of *Rana septentrionalis* is as solitary as the adult.

The tadpole has the odor of the frog, though not so strong; there is a band down the side, but it is not raised above the skin, being flat and a yellowish-green color, and disappears after the absorption of the tail. The beautiful soft hazel of the iris is there, and when looked at in sunlight the same mild expression of the face exhibits both innocence and repose.

There are certain peculiarities in the life-history and in external forms of these three *Ranæ* which so thoroughly agree that they may be separated into a group by themselves. These I shall endeavor to point out as concisely as possible:

1. They have no "chant amour," or love notes, in spring.
2. They retire early to hibernate with the first autumnal frosts.
3. They live in the water and lie in wait for their food, but do not hunt for it on land. They poise the body on any floating weeds, lie on the bank or any bit of stick or log that suits their purpose.
4. The tadpoles of *R. catesbiana* and *R. fontinalis* require two years to mature, and the mink frog requires the same period.
5. Adults in all three have no lateral fold, but merely a slight raising of the skin from the angle of the mouth, and which terminates or shades off on the shoulder.
6. The foot is broader in proportion than in the rest of the family, and the second toe is proportionally shorter, a peculiarity emphatically distinct, and can be seen at a glance by any one who takes the trouble of even a cursory observation. Webbed to extremities.
7. When captured they sometimes utter a cry of distress quite different from their ordinary croaking notes, and I have often

seen the bull-frog open his mouth and scream for over a minute, like a child in distress.

8. When they give their note it is always produced by inflating the throat pouch and suddenly expelling the air, whereas in *R. halecina* there is a pouch near the angle of the jaws, on either side.

9. They are all tinged, more or less, with yellowish-green on the chin, which soon shades towards the throat and breast, and on the belly is white, more or less, in many subjects most beautifully so.

There is thus an analogy in their life-history, and in their external conformation that at once forms them into a group by themselves, and makes a marked section. I am not aware, however, that there is any anatomical difference sufficient to make a genus. In fact I may be allowed to remark that anatomical variations are more frequent among the Batrachia than among any other class of the animal kingdom. There are species that even produce the ova fully fertilized, viz., the *Siredon* genus, before the larva is perfect. The bones in the feet of some species are never fully developed, and in others, closely allied, the bones are perfectly formed. But this is a subject in itself, on which much can be written, and at best such a subject can only end in theory and personal ideas.

The love notes of the *Ranidæ*, admirably termed "chant amour" by the French, is a point in their history I have seldom or never seen noticed in American works, and is a peculiar feature in this "*life-history*" that most emphatically marks whole sections. If I hear the notes of a frog, I can tell to what class it belongs, and when to expect its spawning season. On the 24th of June I collected a number of *R. septentrionalis* and placed them in a large, white, earthen vase. They remained quiet for a time, and I put in some chips and a quantity of *Ranunculus*. Next morning three couples were paired and lying at the bottom of the vase, and secreted among the *Ranunculus*. One pair were on the surface, but the female had been injured. It thus seems they accouple in the night, and immediately sink and hide. Occasionally there was a trivial chant amour from the last pair, evidently so given, but the others were mute. The *R. halecina* may often be heard croaking its lugubrious and dismal love notes from the bottom of some muddy ditch. That of the mink frog is a rapid

squeaking croak almost like the notes uttered by a toad when seized, with the finger and thumb, by its arm pits. I have since heard the same love cry late in the evening, on the banks of the stream, and have well recognized its peculiarly sharp ringing croak. The male seizes the female by the lower portion of the axilla, near the upper third of the dorsal vertebræ, but not by the lumbar regions. At this time the tinting on the chin and throat was a fine gamboge-yellow, and was deeper toned in some specimens than others, but not particularly more in the males than the females. In both sexes it was equally beautiful. I could not help being particularly struck by the extreme stillness of the pairs in coitu among the *Ranunculus*. Nothing seemed to induce them to move in any manner. They were at rest. I carefully examined since on all opportunities, and searched the streams and pools to find some in coitu, if possible, to observe them in their natural embrace, but as yet without success. As mentioned, the ordinary note of this frog is similar to that of *R. halecina*, but much more sprightly, and its note of distress is little different, yet is more sepulchral. I have seen it distend the throat on both sides of the tongue and give this peculiar cry, and there was a considerable depression in the center, over the glossal bones, which demonstrated a sack on each side.

Thus it may be justly inferred that after the female is grasped the pair sink to the bottom and conceal themselves from view and that they either bury themselves in the mud or seek the covering of water plants, after the manner of those in the earthen vase. It is likely some prompting of nature that thus makes them bury themselves from sight, to protect themselves from enemies that could, at that time, make them an easy prey, and in security perform their process of fecundation. I kept my specimens referred to for over a fortnight, but no spawn was deposited. To-day is the 30th July. On the 24th a fine lot was secured, with a number of tadpoles, and sent to the Smithsonian Institution. The color on the chin has much faded, and is now of a creamy-yellow, telling us that the spawning season is over. The same creamy color is seen when they first make their appearance in the beginning of May or in April. Specimens examined to-day are devoid of ova, are considerably collapsed, and the sides are sunk in. There is plenty of spawn in the streams; in some places it is seen adhering to water plants and waving in the

current; in others in bunches, in little bays, but in all places situated half way between the bottom and surface of the water. I also saw two similar bunches of spawn on the 24th June. It is therefore conclusive that *Rana septentrionalis*, the mink frog, spawns towards the end of July. On the 24th ult. I obtained several tadpoles, one a nearly perfected frog with only a small fragment of the tail to be absorbed; several had both legs and arms, and others the hind legs with the arms quite ready to make their appearance, and the skin confining them at the shoulders, transparent. Frogs now spawned cannot be completed this season, as there are plenty of tadpoles in October and in November of *R. catesbiana*, *septentrionalis* and *clamata*. They are seen, all of them, without limbs in spring, and at the present moment they are all three being perfected and assuming the imago, or perfected form. Thus it requires two years to perfect this little frog. From my own observations and from the proportional size of numerous specimens, it requires two years more to bring them to maturity.

Whether it was the effect of placing over a score together in the middle of June that caused their accouplement, I am unable to say, but there was no spawn deposited, which takes place at once in natural positions after coitu.

In studying the "life-history" of any species, it must be carefully traced, step by step. Analogy here is no criterion whatever, and often ends in conclusions far remote from facts—errors needing much trouble to rectify.

On the 2d of July a brook was examined that empties into the Lucknow river, and on a small rapid, shallow and broad, with a sandy and pebbly bottom, a cluster of tadpoles, of the species under consideration, was seen in a great disturbance, each individual on the outside endeavoring to force its way to some object in the general center. This proved to be a brook trout, *Salmo fontinalis*. It was covered with tadpoles, and nothing but the back bone was left, and a small portion of the head, sufficient to identify it. In another similar spot I disturbed a fresh colony and secured the skeleton of a chub, which had also been eaten, nothing remaining but the back bones, head and tail. This is now preserved in alcohol, and every atom of flesh had been eaten off, scales and intestines included.

About twenty of the tadpoles were taken home and placed in a large glass vase filled with rain water. They were in various stages of growth, some not much over an inch, and others with

the legs far advanced, and nearly four inches long. Anxious to discover if this frog, in its tadpole state, was essentially carnivorous, I dropped into the vase several small dead fishes. Next morning they were entirely consumed except the heads and the bones of the back. They always began to eat the soft parts of the belly and intestines, and then the rest of the fish. Thus I continued to feed them, and preserved several fragments of animals devoured. Several dead tadpoles of *R. clamata* were given them, the intestines of which were filled with mud and vegetable matter. So thoroughly carnivorous were these little creatures that no fragment of any part of the body or head was left except the engorged intestines. These relics I placed with the rest, and have them carefully preserved. I have opened a number of these tadpoles, taken from the stream and dropped in alcohol, and their intestines were often full of the common muddy matter found in all species, but on most occasions it was mixed with decaying animal matter, and small fish scales were visible when the matter was placed on the field of a microscope. I placed the soft vegetable substance, on which *R. clamata* feeds, in their jar, and they seemed indifferent to it, but as soon as a dead fish or tadpole was thrown in they immediately gave it their attention, invariably commencing to tear it open about the anus, and then the rest of the abdomen was quickly devoured, with all its contents. I never saw them wrangling over their food, as is always seen among little fish, nor on any occasion did one tadpole chase another.¹

It may be justly asked, "Suppose a number of tadpoles of various species were mixed together in a vase of water, how could one species be distinguished from the other?" The tadpoles are a study in themselves, and it requires long observation, and close inspection, to tell each apart, as they are often so similar in stages that it is no easy undertaking. It would require many pages to point out all their differences, and even then the unscientific reader would be left in a cloudy labyrinth. However, let us point out the characteristics of this species, and how it may generally be known. It is larger in proportion to its size than any of the other American frogs when compared with the adult. The following are its measurements immediately before the arms are excluded from the skin, when the larva is at its greatest length, and is the mean measurement of nine specimens.

¹ This habit was first observed in the tadpoles of *Rana sylvatica* by Professor Baird.

Length from nose to extremity of tail.....	4	inches.
do. of body and head.....	$1\frac{1}{2}$	do.
do. tail.....	$2\frac{5}{8}$	do.
do. head.....	$\frac{5}{8}$	do.
End of snout to inner canthus.....	$1\frac{5}{8}$	do.
Bronchial orifice to anus.....	$\frac{1}{2}$	do.
Breadth of tail at anus.....	$\frac{1}{2}$	do.
do. in centre.....	$\frac{7}{8}$	do.
The entire leg in length.....	$1\frac{1}{4}$	do.

When the legs first begin to show their development they are a reddish-brown tint, and as they become more developed, become more spotted or banded, the upper surface colored as the adult. The coloration of this species, as now before me, is so different from all others I have seen that it may be looked on as specific, and I shall describe this pretty tadpole. The back is a deep grassy-green, with numerous sooty spots. From the external canthus to the insertion of the tail is an olive-yellow line, more or less pronounced in various specimens. The sides are green, with very many punctations of black, and a few spots of the same color scattered among them. The abdomen is white, and the separation of the colors on the sides is perfectly pronounced. Lips edged with black. The cheeks are iridescent green, and red, with a beautiful silvery tinge. The upper edge of the fin of the tail, as also the lower, are well marked with a line of black spots. Down the center, on each side, runs a line of black spots that continues to the end of the tail, but are variously developed in various specimens. The first half of the tail is most beautiful, deep, iridescent green, with many red and aurora-colored shades, that seem to melt into a silver plate beneath. The eye is a perfect hazel brown, or reddish, and, as already stated, is persistent in all stages of this frog. From the angle of the mouth, for nearly half an inch, is a well defined, narrow, black line. In young specimens, the throat and chin are mottled with sooty brown, as in almost all the other tadpoles, which gradually disappears with growth, and, towards maturity, entirely vanishes.

This tadpole is extremely active, and the tail much longer in proportion than any of our North American frogs with which I am acquainted, and, at the same time, narrower. A few days ago I saw several little heads sticking up among the beds of Potamogeton, and after much trouble secured two specimens. I saw one rush at, seize a large ephemera that came near it, and swallow it

yet it had not more than the third of its tail absorbed. I have observed the same in *R. catesbiana*, the bull-frog, but have never as yet noticed that of the *R. clamata* do so. These three species remain silent after they first appear, until the rays of the sun warms the water they inhabit, when the last two render the swamps monotonously hideous, all night long, by an unceasing and seemingly senseless clatter. There is a peculiar reverberation in the notes of all frogs that renders it difficult to locate the exact spot from which it comes. I may mention in passing that I have stood on the mountain above Hamilton, at the head of Lake Ontario, and distinctly heard the bellow of the bull-frog at the further side of Burlington bay and in Dundas swamp, a distance of from four to six miles. These notes were weird and strange, and were truly a witchery on the air in the still summer night.

The tadpole of *R. septentrionalis* much resembles that of *Alytes obstetricans*, so well described by M. F. Lataste, of Paris, a highly distinguished herpetologist, whom I have the honor of numbering among my corresponding friends. He lately sent me his "Etude du Discoglosse," and among all the numerous works I have read on herpetological subjects this stands preëminently forth, for its scientific precision, acumen, and marked ability. In some points *Discoglossus pictus* seems to approach our Canadian *Rana septentrionalis*, which can be pointed out in some subsequent paper.

In regard to its geographical range it seems truly a northern form. It is mentioned in the local issue of the Bulletin of the U. S. National Museum, No. 24, by Dr. Yarrow, that there are specimens from Utah, Oregon, California, Moose river, Red river of the North, both the last in British America, and I can add Ontario and Manitoba. From this it is seen that it has a wide distribution, but being of a retiring nature it has doubtless been overlooked by collectors in many regions. Every animal has its place in creation to be for the general good. This seems to take its place, in the early stages of its career, as a scavenger of our streams, and in the adult, as keeping down the over-abundance of the insects that inhabit streams and their borders. I notice, also that it has been termed the "Rocky Mountain frog," but this name seems to me utterly untenable, as it does not belong to that region particularly, nor was it first discovered there; however, this is a point of not the slightest importance, and if any one is gratified with the name, it gives me pleasure to know it.